

The 'Golden Age' of synesthesia inquiry in the late Nineteenth Century (1876–1895)

Article (Published Version)

Jewanski, Jörg, Simner, Julia, Day, Sean A, Rothen, Nicolas and Ward, Jamie (2019) The 'Golden Age' of synesthesia inquiry in the late Nineteenth Century (1876–1895). *Journal of the History of the Neurosciences*. ISSN 0964-704X

This version is available from Sussex Research Online: <http://sro.sussex.ac.uk/id/eprint/84683/>

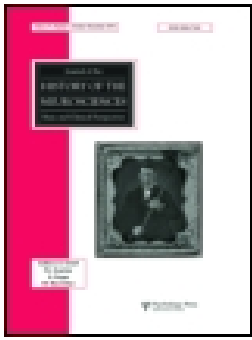
This document is made available in accordance with publisher policies and may differ from the published version or from the version of record. If you wish to cite this item you are advised to consult the publisher's version. Please see the URL above for details on accessing the published version.

Copyright and reuse:

Sussex Research Online is a digital repository of the research output of the University.

Copyright and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable, the material made available in SRO has been checked for eligibility before being made available.

Copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.



Journal of the History of the Neurosciences

Basic and Clinical Perspectives

ISSN: 0964-704X (Print) 1744-5213 (Online) Journal homepage: <https://www.tandfonline.com/loi/njhn20>

The “golden age” of synesthesia inquiry in the late nineteenth century (1876–1895)

Jörg Jewanski, Julia Simner, Sean A. Day, Nicolas Rothen & Jamie Ward

To cite this article: Jörg Jewanski, Julia Simner, Sean A. Day, Nicolas Rothen & Jamie Ward (2019): The “golden age” of synesthesia inquiry in the late nineteenth century (1876–1895), Journal of the History of the Neurosciences, DOI: [10.1080/0964704X.2019.1636348](https://doi.org/10.1080/0964704X.2019.1636348)

To link to this article: <https://doi.org/10.1080/0964704X.2019.1636348>



© 2019 The Author(s). Published with license by Taylor & Francis Group, LLC.



Published online: 29 Jul 2019.



Submit your article to this journal [↗](#)



Article views: 87



View Crossmark data [↗](#)

The “golden age” of synesthesia inquiry in the late nineteenth century (1876–1895)

Jörg Jewanski^{a,b}, Julia Simner^c, Sean A. Day^d, Nicolas Rothen^e and Jamie Ward^c

^aInstitute of Musicology, University of Vienna, Vienna, Austria; ^bDepartment Musikhochschule, University of Münster, Münster, Germany; ^cSchool of Psychology, University of Sussex, Brighton, United Kingdom;

^dDepartment of Behavioral and Social Sciences, Trident Technical College, Charleston, South Carolina, USA;

^eFaculty of Psychology, Swiss Distance Learning University, Brig, Switzerland

ABSTRACT

Synesthesia is a rare neurological trait that causes unusual, often cross-sensory, experiences (e.g., seeing colors when listening to music). This article traces the history of synesthesia in the period 1876 to 1895. In this period, there was considerable debate over the nature of synesthesia, its causes, and how it should be named. The issue also attracted the leading thinkers of the time and, within a few years, the number of reported cases of synesthesia jumped from around ten to more than 100. For this reason, this period can be regarded as the “golden age” for synesthesia research in the nineteenth century. In this time, scientists debated whether synesthesia was a form of pathology or an alternative manifestation of intelligence. The differing roles of heredity and environment were contested, and there were several explanations proposed as to its neural basis. These enquiries went to the heart of the debate as to whether synesthetic experiences are special in any way or, instead, a more vivid manifestation of a more general capacity for forming associations.



KEYWORDS

Synesthesia; nineteenth century; Gustav Theodor Fechner; Francis Galton; Paul Bleuler; Karl Lehmann; Eduard Gruber; Théodore Flournoy; Mary Whiton Calkins

Introduction

Synesthesia is an unusual form of experiencing the world in which music may elicit colors, numbers may be visualized as a line running through space, and words might have tastes. These many different variants of synesthesia today have different names (e.g., experiencing colors from letters or numbers is called *grapheme-color synesthesia*), but all today fall under the broad umbrella term of *synesthesia*. The experiences tend to be automatic and consistent over time. The developmental form is present from early childhood, runs in families, and has a prevalence of around 4% (for a review, see Simner and Hubbard 2013; Ward 2013). The condition is linked to structural and functional differences in the brain (Rouw, Scholte, and Colizoli 2011), but is not considered pathological.

This article traces the history of synesthesia in the period 1876 to 1895. Within this period, there was considerable debate over the nature of synesthesia, its causes, and what it should be called. The topic also attracted the leading thinkers of the time and, within a few years, the number of reported cases jumped from around ten to more than 100. For this

CONTACT Jörg Jewanski  Jewanski@gmx.de  Institut für Musikwissenschaft, Universität Wien, Spitalgasse 2, Hof 9 (Campus), A-1090 Wien, Austria.

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/njhn.

© 2019 The Author(s). Published with license by Taylor & Francis Group, LLC.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

reason, this period can be regarded as the “golden age” for synesthesia research in the nineteenth century. Our starting year, 1876, saw the first attempt to collect a series of cases from sampling in the general public (Fechner 1876), and our ending year, 1895, saw the first publication with the name *synesthesia* within an academic title and referring to a broadly similar concept to the one we understand today (Calkins 1895). Within this period, we present the ideas of leading scientists.

This article is the third part of an historical exploration of synesthesia, published by us in this journal. In the first part, we examined the first documented case of synesthesia—Georg Tobias Ludwig Sachs, from 1812—and potential cases before that date (Jewanski, Day, and Ward 2009). Two years later, we summarized single case studies from the mid-nineteenth century (1849–1873) that focused in particular on music-color synesthesia (i.e., seeing colors while listening to music; Jewanski et al. 2011).

By this time, several ideas had been proposed about the origins of synesthesia. Some favored environmental explanations based on, for instance, childhood associations (e.g., grapheme-color synesthesia is formed from reading childhood alphabet books; Chabrier 1864), whereas others proposed explanations based on contemporary ideas of brain functioning. For instance, Lussana (1873) suggested that the color center of the brain may be next to those involved in processing music and language, hence providing opportunities for them to “connect” in certain people. In a similar vein, Pouchet and Tournoux (1878, 396) described synesthesia in terms of “abnormal routing of nerve fibers from the ear arriving in perceptual centers that would normally be exclusively affected by tubes from the optic nerve.”

In the period from 1876 to 1895, there was a shift away from single cases (discovered by chance) to survey studies in which synesthetes were found by sampling. This afforded new opportunities: Many new types of synesthesia were documented, and comparisons across cases became feasible. This review traces these major developments, starting in 1876.¹

This article discussion has a Western/European foundation. Although a global research history is regarded by us as necessary, due to sources known today from the nineteenth century—which do not include ones from South America, Africa, Asia, or even from Australia—we can only provide the article at hand. Some examples of this: The first known South American article on synesthesia was an empirical study with school children published in Argentina (Mercante 1908); the first Asian study on synesthesia was published in India and presented two case studies, based on conversations with the probands from 1918 on (Banerji 1930). Both articles lay outside of our time frame. In Russia, the first scientific article on synesthesia was published in 1893 (cf. Sidoroff-Dorso 2012, 2014); it is near the chronological end point of our article and therefore only marginally supported a golden age of synesthesia inquiry (1876 to 1895).

The first survey of letter-to-color associations: Fechner 1876

Gustav Theodor Fechner (1801–1887) was already an eminent figure in psychology and neuroscience when he documented several probable cases of synesthesia. Fechner had paved the way for modern psychology with the publication of his work *Elemente der Psychophysik* (1860, transl. 1966), in which he attempted to explain the lawful relationship

¹All quotations that are not originally in English have been translated, if not otherwise marked.

between psychological sensations and physical properties of the world. He had a particular interest in color vision and studied various visual illusions, including the “Fechner color illusion,” in which rapidly changing black-and-white patterns can induce sensations of color.

At the age of 75, Fechner published the two-volume *Vorschule der Aesthetik* (1876, never published in English). In the first volume, he discussed the possibility of interpreting music in different ways, confirmed that music can be matched with distinct associations that can replace words, and afterward described color associations to vowels given to him by four acquaintances (pp. 175–177). There is no source supposing that Fechner was a synesthete; he only was analyzing associations. As for their origins, he made two observations. First, some color associations to vowels may derive from the color name in which the vowels appear. For instance, *e* may be yellow because it appears in the German word *gelb*. However, he also noted that this cannot always be the case:

Since *c* and *z*, *f* and *v*, *k* and *q*, *i* and *y*, although sounding the same, arise here with a different color character, then these can only depend upon ideas which attach to the different usage and perhaps even to the different shape of these letters. (Fechner 1876, Vol. 1, 177)

At least two of the four people mentioned by Fechner were probably synesthetes, because they indicated that they held their associations “very firmly” (p. 177) and provided detailed descriptions of associations: respectively, *f* with “cherry brown,” and “long solemn tones” with “long cylinders” (p. 177).

It is in the second volume that Fechner broke with tradition. He conducted a survey of color associations to vowels, noting some 73 cases containing an approximately even mix of males and females. This was the first attempt by any researcher to find correlations between vowels and colors, and Fechner likely sampled both genuine synesthetes, and also nonsynesthetes, describing nothing more than everyday intuitions (known as cross-modal correspondences). Fechner did not mention any article about synesthesia published by his forerunners; therefore, it is not clear what he knew about this phenomenon, but he described different levels of associations:

Not all people whom one contacts for this reason with a question deal with the comparison concerned, while very many explain that they do not know how to construct such at all; but these are decidedly outweighed by the number of those, of which there are not a few, who employed such already before by their own hands. (Fechner 1876, Vol. 2, 315)

This last group may be synesthetes, but during Fechner’s lifetime no differentiation was made between synesthesia and everyday correspondences (i.e., intuitions found in the population at large). Even today, this point is debated, with some suggesting links between synesthesia and correspondences (e.g., Simner and Ludwig 2011) and others disputing this (e.g., Deroy and Spence 2013). Nonetheless, Fechner’s survey revealed some common trends: *a* tends to be *white*, *e* and *i* tend to be *yellow*, *o* is either *indefinite* or *red*, and *u* tends to be *dark* (black, brown, or violet). Nonrandom trends are found in contemporary synesthetic samples (e.g., Simner et al. 2005), although the colors do not correspond closely to those reported by Fechner, perhaps because of his undoubtedly mixed sample.

Four years later, Fechner, in collaboration with the Academic-Philosophical Society in Leipzig, published a request in journals for readers to send him an answer regarding

whether any had “totally unconstrained, clear and distinct” color associations for vowels, numbers, days of the week, or musical keys.

Prof. Fechner generally wishes only educated judgements. The participation of ladies would be particularly valuable to him. Towards completed information, it is asked to add the name of the person, the status and place of residence, as this may also prove to be a regularity. (Akademisch-Philosophischer Verein Leipzig 1880)

Fechner also developed a (today lost) questionnaire, which he sent to acquaintances and celebrities in Germany, Great Britain, New York, Sweden, Italy, Switzerland, and even Greece (Steinbrügge 1887). Fechner did not publish an article about it; instead, his data were donated shortly before his death to the otologist Hermann Steinbrügge (1831–1901). On July 9, 1887, during his inaugural lecture as a professor of medicine at the University of Giessen, Germany, *Über sekundäre Sinnesempfindungen* (On Secondary Sensations of the Senses; Steinbrügge 1887), Steinbrügge reported on Fechner’s survey: 141 questionnaires were sent, 40 came back. Beside this, Fechner had collected many messages, altogether 442 cases of color associations; 347 of them were considered strong cases (including two blind persons and one color-blind). It is unclear how many of them can be regarded as synesthetes in our modern terminology. Steinbrügge evaluated them only in a general way: The vowels *a*, *e*, and *i* are mostly associated with bright colors, *o* and *u* with dark colors; in detail, the data differ a lot and there is no focus on heredity inside the questionnaire. Whereas Fechner’s own writing does not make it clear whether he distinguished (or wanted to distinguish) between correspondences and synesthesia, Steinbrügge clarified:

Fechner had wished that even such persons who did not have the gift of associations should fill out the questionnaire to maximize material for comparative statistics. (Steinbrügge 1887, 17)

The “gift of associations” means synesthesia. Steinbrügge wrote, with regard to Fechner’s documents:

It follows from many reports, ... that the majority of respondents, who are not endowed with associations, can do nothing at all, and dismiss the questioner with a certain mistrust and often with mocking remarks. ... Another Berliner shares that he had questioned many people, but did not encounter any results; only, in many cases, cheerful faces. (Steinbrügge 1887, 17–18)

As we will see in the next section, Francis Galton encountered similar problems when asking people about their synesthesia.

Synesthesia as a variant of mental imagery ability: Galton 1880–1883

Sir Francis Galton (1822–1911) was a British polymath who contributed to the fields of geography, anthropology, statistics (e.g., creating the concept of correlation), forensic science (e.g., devising a method for fingerprinting), and psychology. Galton was particularly interested in the inheritance of mental traits, which he studied by analyzing pedigrees (coining the phrase “nature and nurture”) and, for the first time, the use of twin studies (comparing identical and nonidentical twins). Shortly after these important works, Galton’s interest turned to mental imagery. According to Burbridge (1994), it was Galton’s chance discovery of “number forms” (known today as *sequence-space synesthesia*,

in which numbers are paired with locations in space) that likely propelled his interest in mental imagery, rather than vice versa.

Galton's interest was also encouraged by the case of George Bidder, the son of a famous calculating prodigy and engineer of the same name (George Bidder senior, 1806–1878). In December 1878, the junior Bidder wrote an article in which he commented on both his and his recently deceased father's visual imageries. Galton's interest was piqued by the familial pattern, and he wrote to Bidder to ask for more details. In his reply, Bidder gave a description and diagram of his own number form in addition to an account of his general visual imagery abilities (letter dated April 14, 1879; held in Special Collection, University College London, Galton 152/6A). Bidder's hand-drawn number form is reproduced in Figure 1, together with a previously unpublished document attached to the same letter showing a “calendar form” and “historical form”—both variants of sequence-space synesthesia encoding time units in particular (but known at the time under the same name of “number forms”).

Between November 1879 and April 1880, Galton distributed many hundreds of copies of a questionnaire (the text of which is given in Burbridge 1994, Table 1, 448–49) asking about various aspects of mental imagery (not limited to vision). In 1880/1881, he published a dozen articles (some of them are reprints) and, as a summary, a book chapter about it (Galton 1880a–1880f, 1881, 1883, 114–77). By March 1880, he had amassed 80 cases of “visualised numerals” that mostly consisted of number forms (Galton 1880c). Galton also noted similar forms for dates, days of the week, and months of the year, but he did not document these in detail because he believed that these representations bear similarity to those found in books, whereas those for numbers did not (Galton 1880a). In addition, Galton noted “many curious cases of colour association with the various numerals” (Galton 1880a, 252). However, he gave actual examples from only one such case in his earliest paper (Galton 1880a), although two further discussants mention

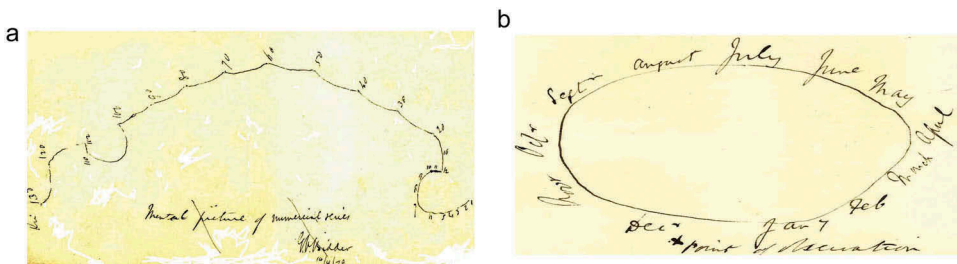


Figure 1. Galton first became aware of sequence-space synesthesia following an article by George Bidder, with whom he subsequently exchanged letters. The figure shows Bidder's original drawings, sent to Galton, of his forms for numbers and the calendar (his form for historical time is not shown). “One of the most curious peculiarities in my own case, is the arrangement of arithmetic numerals. I have sketched this to the best of my ability. Every number ... is always thought of by me in its own definite place in the series, where it has if I may say so, a home and individuality. ... Similarly if I have occasion to think of the months or days of the year it is always in a circle around which the months are arranged and the dates are referred to their proper place in the circle. It is worth noting that the point of observation from which I seem to [illegible, “see”?] the circle is always the same [illegible] below December. So again in history—the English kings are thought of in definite positions” (quoting from Bidder's letter of April 14, 1879; held in Special Collection, University College London, Galton 152/6A).

colored letters and colored days in response to his paper presented at the Anthropological Institute in March 1880 (Galton 1880f). Later in the same year, Galton reported knowing of 20 cases of color associations to letters, numbers, days, and months (Galton 1880e). Altogether, he “formed a collection of hundreds of such cases, not only from English but from American, French, German, Italian, Austrian, and Russian correspondents.” (Pearson 1924, 240)

Galton did not recognize the importance of these color associations with respect to the earlier research in mainland Europe. It was only in a monograph (Galton 1883) that he made any reference to these earlier cases, citing Lewes’s (1879) description of the Nussbaumer brothers (who both experienced synesthetic colors) and the extensive work on synesthesia by Bleuler and Lehmann (1881; see below). In addition, Galton reported two other phenomena that many contemporary researchers would regard as synesthetic. First, the appearance of visualized numerals in very particular typeface when spoken; for instance, the spoken number “nine” being automatically perceived as “9” (Galton 1880a). This has been referred to as “tickertape” synesthesia (e.g., Chun and Hupé 2013), in which speech is automatically visualized in written form, sometimes with each word or letter colored (see also Baron-Cohen et al. 1993). Second, Galton documented a case of *sequence-personality synesthesia* (i.e., the personification of numbers), which is the earliest source for this kind of synesthesia (Plassart and White 2017):

The numerals 1, 2, 3, 4, etc. ... have been personified by me from childhood. 9 is a wonderful being of whom I felt almost afraid, 8 I took for his wife ... 7 again is masculine; 6, of no particular sex but gentle and straightforward. ... In this style the whole multiplication table consisted of the actions of living persons, whom I liked or disliked, and who had, though only vaguely, human forms. (Galton 1880a, 253)

Although one could give credit to Galton for being the first to link these rather different types of synesthesia together, this would be a misunderstanding of his ideas. For Galton, number forms, color associations, and personifications were just as related to other visual phenomena as they were to each other. In his view, mental imagery encompassed visual memory of scenes, hypnogogic imagery, and visual hallucinations, as well as the number forms and other associations that would now come under the umbrella of synesthesia (including grapheme-color). He did not offer any terminology for synesthesia itself (i.e., the collection of characteristics we would recognize today) because, under his account, none was needed: They were simply variants of mental imagery ability.

Galton offers his most detailed account of the origins of number forms in the following passages:

These forms ... are survivals of a very early mental stage, and must have originated before the child learnt his letters. There is no nursery book or diagram that could suggest their fantastic shapes. Their very variety shows them to be derived from no common origin. ... I believe the forms to have been mnemonic diagrams, invented by the children when they were learning to count *verbally*, the *sounds* of the successive numerals being associated with the successive points of the form. ... These forms or natural lines of thought are, I presume, analogous to those that instinctively prompt each species of animal to make his lair ... with trifling individual variations. ... I find from inquiries made for me at schools that young people see forms more commonly than adults ... I conclude that where they are vivid and serviceable they are much used, and insensibly grow in vividness, in definition and in automatic

character. Otherwise they decay from disuse and become forgotten. Hence arises the rather sharp division between the seers and non-seers in adult life. (Galton 1880c, 495)

Galton also reported his own estimates of prevalence (one in 30 men, one in 15 women [1880c, 1880f], and one in four schoolboys [Galton 1880d]). These estimates are similar to those reported in another study some years later (Patrick 1893) and, in adults at least, resemble contemporary estimates (if we ignore the suggested male bias, which likely arose from sampling issues; Sagiv et al. 2006). The greater prevalence in school children has not been borne out by contemporary studies of other types of synesthesia (e.g., grapheme-color), although sample sizes and methodological limitations make comparisons between adults and children difficult (for discussion, see Simner et al. 2009). Galton also documented number forms among some notable scientists of the day, including Arthur Schuster (1851–1934, physicist and Fellow of the Royal Society), and lexicographer and son of the inventor of the thesaurus, John Roget (1828–1908).

Galton believed number forms to be hereditary, by which he meant that the tendency to associate numbers spatially is instinctive and universal. In order to account for the fact that only some adults possess this tendency, Galton proposed a “use it or lose it” mechanism. As such, there was a subtle but important difference between Galton’s hereditary account and contemporary ones. Whereas Galton argued that number forms are lost if an individual ceases to use them, contemporary studies have suggested that the process of losing synesthesia during development is genetically mediated (i.e., all children may be born synesthetic, given what we know about early brain connectivity, but some children are predisposed to retain it; see Maurer, Gibson, and Spector 2013).

As we have already seen, Fechner had problems asking people about their synesthesia because it was an unknown topic and people thought he was joking. This was a typical situation even around 1880, as we can see with Galton:

At a meeting of the British Association, in which Galton held a lecture on the subject, at the end of his speech, he asked the assembled to report by raising a hand if they saw similar images. But no one risked it. Then Galton told a witty story he had read in the Times, and then said: “This is how everyone who sees such number lines in this Assembly has done, so I did not receive an answer to my question; but I cannot drop my subject, therefore I call upon Prof. S., whom I see on the tribune and of which I know that he sees these kinds of pictures, to raise his hand, and then hope that you who have hitherto held back from shyness follow his example!” Thereupon a whole lot raised hands. (Hey 1930, 373–74; without giving the source for it)

After his intensive period with synesthesia, mainly 1879–1881, Galton retained an interest in it for at least a decade (latest statement: Galton, 1892) and continued to correspond with other scientists about it. Around the same time as Galton was publishing on synesthesia, important parallel research was being conducted in other parts of Europe.

The plurality of synesthesia: Bleuler and Lehmann 1881

Paul Eugen Bleuler (1857–1939) and Karl Bernhard Lehmann (1858–1940) were both eminent scientists during their lifetimes. Bleuler was particularly influential in the field of psychiatry, coining the term *schizophrenia*. Lehmann’s career was principally concerned with hygiene and microbiology. However, it was during their time together as medical students in Switzerland, when both were only 20 years old, that their research into synesthesia was conducted.

In a discussion about chemistry in 1878, Bleuler was not able to remember the appearance of ketones and said, “The ketones are yellow, because there is an o in it” (Bleuler and Lehmann 1881, 1). Lehman did not understand and asked for clarification. Bleuler explained that, for him and also for some of his relatives, the sound of each vowel or word (and even thinking about them) was associated with the image of a specific color. Bleuler had known about these experiences from at least his fifth year on, but until this discussion, he regarded the phenomenon as random and therefore useless, because different people had given contradictory information concerning the colors of specific letters/phonemes. After their discussion, Bleuler asked his relatives and found many synesthetes. By autumn 1878, Bleuler and Lehmann had listed the color for each letter of the alphabet from about a dozen people, and began to extend this beyond their families and beyond letter-color associations. By the end of their investigations, they had interrogated a total of 596 people (383 male, 213 female)—the biggest sample in history for studying synesthesia at this time—and they had published a monograph, *Zwangsmässige Lichtempfindungen durch Schall und verwandte Erscheinungen auf dem Gebiete der andern Sinnesempfindungen* (Compulsory Light Sensations Through Sound and Related Phenomena in the Domain of Other Sensations) in 1881.

As a result of their enquiries, the following list was produced of “double sensations,” as synesthesia was named by Bleuler and Lehmann (1881, 3–4):

- (1) sound photisms—light, color, and form sensations, which are elicited through hearing;
- (2) light phonisms—sound sensations, which are elicited through seeing;
- (3) gustation photisms—color sensations for gustation perceptions;
- (4) olfactory photisms—color sensations for olfactory perceptions;
- (5) color and shape sensations for pain, heat, and tactile sensations; and
- (6) color sensations for shapes.

These represent the first reported cases of synesthesia in history in which smell, touch, pain, and taste act as “inducers” (the term used today to denote what triggers synesthesia), and specific accounts of them are given in their appendices. For all specified types, Bleuler and Lehmann found 76 cases experienced synesthesia amongst 596 people (45 male, 31 female). This suggested a prevalence of about 12.8% (14.6% in the female sample and 11.7% in the male sample; Bleuler and Lehmann 1881, 49). This is far higher than contemporary estimates (Simner et al., 2006). However, Bleuler and Lehmann noted that this figure might have been inflated because of their sampling method (i.e., deliberating asking within the families of synesthetes). The female-male ratio (1.2:1) is the same as is now known from contemporary studies, but is in contrast to many studies from the mid- and late-twentieth century, which suggested a much stronger female bias (see Johnson, Allison, and Baron-Cohen 2013, 17). However, these twentieth-century studies had likely encouraged a false female bias by their recruitment methods, which advertised for synesthetes to come forward and self-refer (which disproportionately recruits women) rather than counting synesthetes from the general population using random sampling (for a discussion, see Simner et al. 2006; a ratio of 1.3:1 is discussed in Simner and Carmichael 2015).

Bleuler and Lehmann also emphasized a degree of continuity between people who possess synesthesia and those who do not:

There is, namely, no sharp threshold between people who have these double sensations and those who absolutely do not understand such a relationship. For many individuals, for instance, there are only colors for a few isolated sound experiences. Some have the certain feeling of such a relationship, but are not able to give examples. Finally, many remember such experiences in their adolescence, ... [but] the occurrences more or less washed out over the years. ... One cannot rule out the possibility—many negatives [non-synesthetes] however will shake their heads—that double sensations are existent in the predisposition of everyone, but that for the majority [of people] they are blurred through the remaining experiences of life, respectively, are not able to come to awareness. (Bleuler and Lehmann 1881, 50–51)

In particular, Bleuler and Lehmann were struck by commonalities in how inducers (“primary sensations”) and concurrents (“secondary sensations”) are combined. For instance, they noted that “[b]right photisms are elicited through: high pitched sounds, intense pain, sharply defined tactile sensations, small shapes, pointy shapes. Dark photisms through the opposite” (1881, 96). They also noted how similar expressions are used in everyday metaphorical language (“‘bright tones,’ ‘pointy tones,’ ‘sharp fizzling,’ ‘dull sounds,’ ‘dull feelings,’ ‘sharp smells and tastes,’ ‘screaming colors’ etc”; Bleuler and Lehmann 1881, 51) and used this to support the idea of a continuum between synesthesia and typical modes of perceiving—an idea that today is contrasted by the terms weak synesthesia and strong synesthesia, and whose relation still is regarded as unclear (Martino and Marks 2001, Marks 2013, Deroy and Spence 2013). Bleuler and Lehmann were, however, also keen to point out that synesthesia was not reducible to either language or learned association. They noted the heritable nature, emergence in childhood, the nuances in the color descriptions, and the resilience over time, which, unlike conventional associations, were resistant to extinction or modification.

From an historical perspective, the previous accounts of synesthesia were largely unknown to Bleuler and Lehmann (1881). They linked their discussion of multisensory metaphors to the work of the famous German psychologist Wilhelm Wundt (1874), who had proposed a theory of speech in which there is “phonetic imitation” of vision, touch, and so on. They were unaware of the recent work by Fechner (1876) until their manuscript had been prepared. They were, however, familiar with the case of the Nussbaumer brothers (reported by Nussbaumer 1873a, 1873b; Jewanski et al. 2013) and concurred with Nussbaumer’s neuroscientific account of it.

Nussbaumer assumes some direct link from one [brain] center to another. From the outset, this seems very reasonable. The lowest centers of reflexes of the sensory organs have widespread connections with all the other parts of the central organs. So, the stimulus which arrives at the sensory fibers must in part cross over into the pathway of another sensory organ. Thus, a specific stimulus quality in one organ must excite in exactly the same manner the other, in order for precise and consistent secondary sensations to originate. (Bleuler and Lehmann 1881, 57)

These ideas were also linked to the evolution of species, suggesting that in phylogenesis there was a step at which the different qualities of sensations were not yet separated. In this respect, synesthesia may be a kind of atavism resembling earlier life forms (Bleuler and Lehmann 1881, footnote, p. 58).

Finally, Bleuler and Lehmann provided their readers with tables about the synesthetic experiences of their subjects for different kinds of materials. Furthermore, there is also a summary for every subject containing demographic information and the key characteristics of their synesthetic experiences. One of the tables also provides 10 general rules,

based on the interviews with their 76 subjects (e.g., Rule 8: “The predisposition to secondary sensations is heritable”); the full set of rules is shown in the Appendix.

With regard to one rule (Rule 10: “With psychopathic burdened persons, secondary sensations are not more common than with normal [persons]”), Bleuler and Lehmann were particularly keen to show that synesthesia was not linked to mental illness (a suggestion first made by the professor of electrotherapy and pathology of nerves Moritz Benedikt [1835–1920], see Jewanski et al. 2013), and they provided additional statistics to speak against such a link.

Bleuler and Lehmann’s monograph was the first one in history exclusively devoted to synesthesia (articles by other authors had been reprinted only as booklets). It had a significant impact around the Western world. Two notable effects were the very positive reviews (for example, “Colour-Hearing” in *The Times* 1882) and its first abstract in the United States, which helped pave the way for the beginning of scientific research with synesthesia in this country (Jastrow 1883).

Another notable effect from Bleuler and Lehmann’s monograph was the adoption of the term *colored hearing* and its French and German equivalents, *audition colorée* and *Farbenhören*. Although Bleuler and Lehmann themselves did not use it, the term first appeared in a review of the monograph (Das Farbenhören 1881) and was popularized by an influential, twice-published article by Louis-Marie-Alexis Pédrone (1882a, 1882b; cf. Jewanski et al. 2018).

Pédrone (b. 1859), who later specialized in ophthalmology, was still a student when he published on synesthesia, in parallel to Bleuler and Lehmann. Pédrone gave an overview on the writings of synesthesia (which he named *audition colorée*), and provided a detailed description of a person with colored hearing (sounds, noises, voices, and timbres), explaining the phenomenon as follows:

[W]e allow the theory of irradiation or of associated sensations, we can say that the centers of color and sound are necessarily situated close to each other. ... Whether one supports the idea of an abnormal pathway of nerve fibers coming from the ear, or whether one supports the theory of irradiation, the final phenomenon is excitation associated to the central acoustic and color cells. (Pédrone 1882a, 308 and 310; 1882b, 235 and 237)

Pédrone propelled research on synesthesia forward during the 1880s in France; in this decade, more articles and books about synesthesia were published in France than in any other country, and most of them used the term *audition colorée* within the title. Moreover, it was in France that the first known symposium was held on synesthesia, a major milestone in its scientific history.

The First International Symposium on Synesthesia (Paris 1889) and Gruber’s questionnaire (1893)

The first International Conference of Physiological Psychology, which took place in Paris in 1889, included a separate symposium on synesthesia (for a full review, see Jewanski et al. 2015). The symposium apparently was initiated only during the congress itself, and so did not feature the expected list of people who had already published on this topic. Altogether, nearly 400 scientists were present at the conference, mostly from France, and the average number of participants for each lecture was 60 to 120 (James 1889). Unfortunately, we do not know how many attended the synesthesia symposium. But

probably, most of the participants from the conference knew that there *was* one, likely itself to have been a factor in propelling interest in synesthesia forward.

The symposium in Paris consisted of a panel discussion, which was documented in the conference proceeding (*Société de psychologie physiologique* 1890, 94–96). Eight people were active and contributed 13 statements. The most dominant participant was the Romanian psychologist Eduard Gruber, whose four statements were longer than all of the other ones put together. Gruber became the first in history to compare Western and non-Western letters in the context of synesthesia, although during the conference he was only able to touch on the issue rather than going into detail. Unfortunately, he died too young to publish on it. A recent study with a five-language data set confirmed the necessity to consider cross-linguistic comparisons in grapheme-color synesthesia (Root et al. 2018).

The other members of the symposium knew much less about synesthesia, and mainly asked basic questions. Arthur Sperling, a German specialist in neurological disorders, reported on the Nussbaumer brothers; Benedikt, who had been present at Nussbaumer's lecture in Vienna 1873, repeated his own 16-year-old warning:

It is difficult in such cases to draw an exact boundary between psychology and pathology. The trigeminal nerve plays a major role here; it has immediate connections with all the senses. I would advise not doing too many experiments on these subjects, because the experiments themselves might not be without danger. (*Société de psychologie physiologique* 1890, 95)

Benedikt's idea of a major role of the trigeminal nerve had been new for 1873. In 1883, the Austrian otologist Victor Urbantschitsch had published an article about the influence of the trigememinal nerve on senses, especially on the sense of vision, and was aware of Nussbaumer's as well as of Bleuler and Lehmann's writings, but he had concluded very carefully: "To what extent the color and light sensations transmitted by the hearing ... may be referred to here, I cannot decide" (Urbantschitsch 1883, 174–75, footnote 1). Benedikt's theory was never picked up by others. Today, we know that this nerve is involved in touch, pain, and movement of the face, but it has no connection to synesthesia whatsoever.

The idea of an open border between synesthesia and pathology was endorsed by Finnish psychologist and philosopher Hjalmar Neiglick (1860–1889), who contributed the following to the Paris discussion:

It would be very important, in studying this fact, to examine the mental state of these individuals. This phenomenon could be very dangerous, and lead to madness. These are perhaps the initial symptoms of a state of intellectual degeneration. For this, we only have to simultaneously study the other psychological phenomena which present in these subjects. (*Société de psychologie physiologique* 1890, 96)

After the Paris discussion, a commission was founded, and its mission statement was presented by Gruber the following day. Its aim was to research *audition colorée* (defined in today's terms as broad synesthesia) and create a questionnaire to elicit from participants sound-color associations as well as related facts about synesthesia's inheritance, pathology, and phenomenology (*Société de psychologie physiologique* 1890, 157).

Also stemming from the conference were notable publications by scientists who became experts on synesthesia. These included Ferdinand Suarez de Mendoza, who in 1890 published the longest list of known synesthetes with color experiences up until that date ($N = 134$ from 36 sources, including eight cases of his own), and Théodore Flournoy (who was part of the commission), whom we discuss below. The conference also likely

influenced others known primarily for expertise outside synesthesia, including American philosopher William James (who attended the meeting) and French psychologist Alfred Binet (1857–1911), whose name is on the conference’s member list. Binet published an article in French about synesthesia (Binet 1892a), which was translated into English twice (Binet 1892b, 1893a), German (Binet 1893b), and even Russian (Binet 1894), and became one of the most widespread articles written about synesthesia during the whole of the nineteenth century. Here Binet continued with the ideas of Galton, who had argued that “synesthesias” were simply variants of mental imagery ability:

In colored audition there is no double perception, nor what is called a synæsthesia. All takes place in the imagination of the subject; the impressions of color of which he is conscious on the hearing of certain vowels are not real sensations; they are not colors which one sees with the eyes, but mental images, notions, or we might better compare them with the images which the natural significance of the words excites in the mind. (Binet 1892a, 594; cited from the English translation 1893a, 817)

The questionnaire that was promised in the mission statement presented by Gruber would need several years to emerge, and was ultimately published only by Gruber, but it reflected a number of influences from experimental psychology at that time. We turn now to this questionnaire in more detail, and to Gruber himself. At the time of the Paris Conference, the Romanian Eduard [Édouard] Gruber (Figure 2) worked at Wilhelm Wundt’s famous psychological laboratory in Leipzig.

In the mission statement Gruber presented, he tasked the newly formed commission with the idea of developing a questionnaire and to deliver it for discussion in the following conference, which took place in London in 1892 (August 1–4) and was renamed the International Congress of Experimental Psychology. However, at this London conference, Gruber in fact presented a more general paper on the taxonomy of synesthesia, expanding on that of Bleuler and Lehmann, as shown in Figure 3 (Gruber, 1892; 1893a; 1893b).

Gruber had started a “consistency test” on synesthesia (i.e., to determine whether synesthetes’ sensations change over time) prior to the Paris symposium, and altogether completed four runs: May 1889, February 1890, June 1891, and September/October 1891. Gruber reported that sensations remained the same—that is, linked the same inducer and concurrent. This was the first consistency test that completed several runs (cf. Kaiser 1872 and 1882 with only two runs).

In 1893, Gruber finally published his questionnaire on synesthesia in the French journal *Revue Philosophique de la France et de l’Étranger* (in French, Gruber 1893c; in German, Gruber 1893d), a journal edited by Théodule Ribot, professor of psychology in Paris. Ribot had been one of the vice presidents of the organization committee for the Paris congress 1889, at which Gruber had taken part at the symposium on synesthesia. We reproduce the questionnaire in our SI as an English translation (and rely on both the French and the German versions). The questionnaire asked about synesthetic inducers in great detail (e.g., “consonants, syllables and the diphthongs”; different languages; and names of familiar and unfamiliar people) and included insightful questions such as whether the word “blood,” when pronounced, ever triggered a color such as yellow or blue.

As the phenomenon of synesthesia became more widely known through people such as Gruber, a number of others began to question for the first time whether synesthesia merited scientific study. German professor of medicine Adolf Barth wrote of Gruber, “The

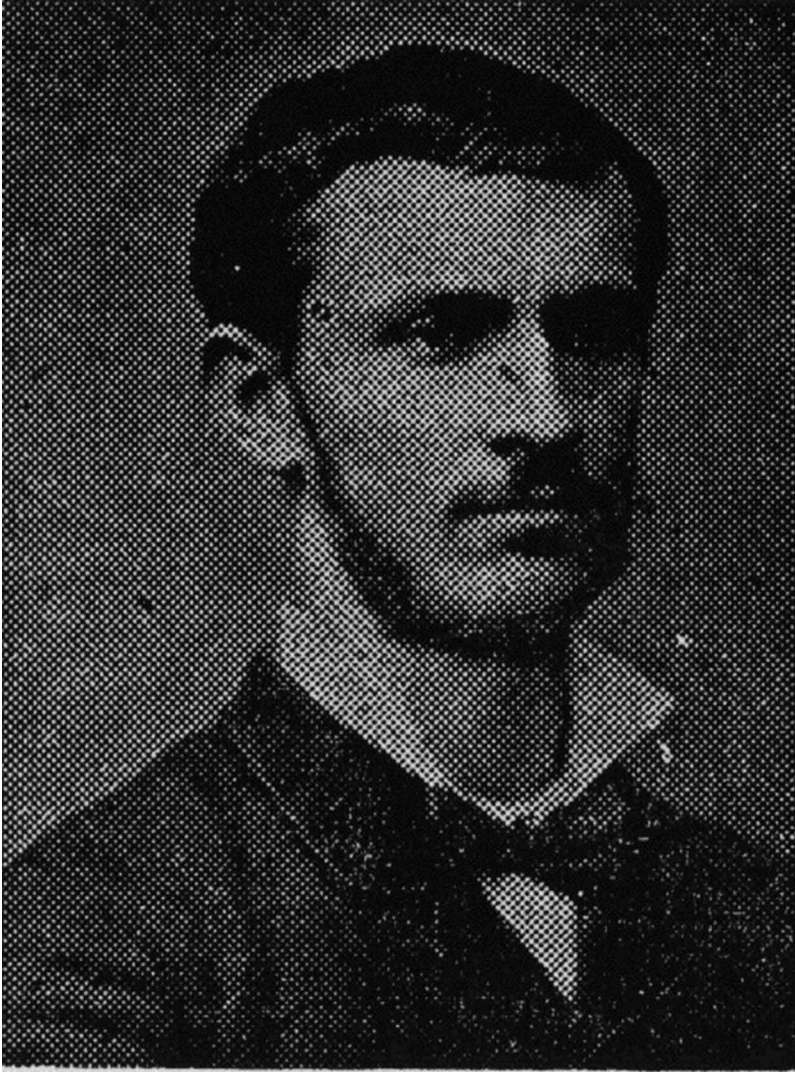


Figure 2. Eduard Gruber (1861–1896); photo: Maftai 1978, 148.

ingenious plaything, which presents sensations of different senses as being more or less allied, soon ought to disappear at least from the exact sciences through investigations like these” (Barth 1894a; German version, Barth 1894b). Likewise, a certain “F. B. D.” wrote in the respected *American Journal of Psychology*, “The facts stated in this paper are very interesting, but perhaps not as important as the author thinks” ([F. B. D.] 1894).

In an 1892 monograph entitled *Entartung* (Degeneration), German social critic Max Nordau discussed synesthesia as well as what we today call cross-modal correspondences (see above). Nordau was aware of the recently published monograph on synesthesia by Suarez de Mendoza (1890), as well as the writings of *fin de siècle* artists, who tended to use cross-modal correspondences in their poetry and prose. Nordau regarded both as somewhat degenerative, writing:

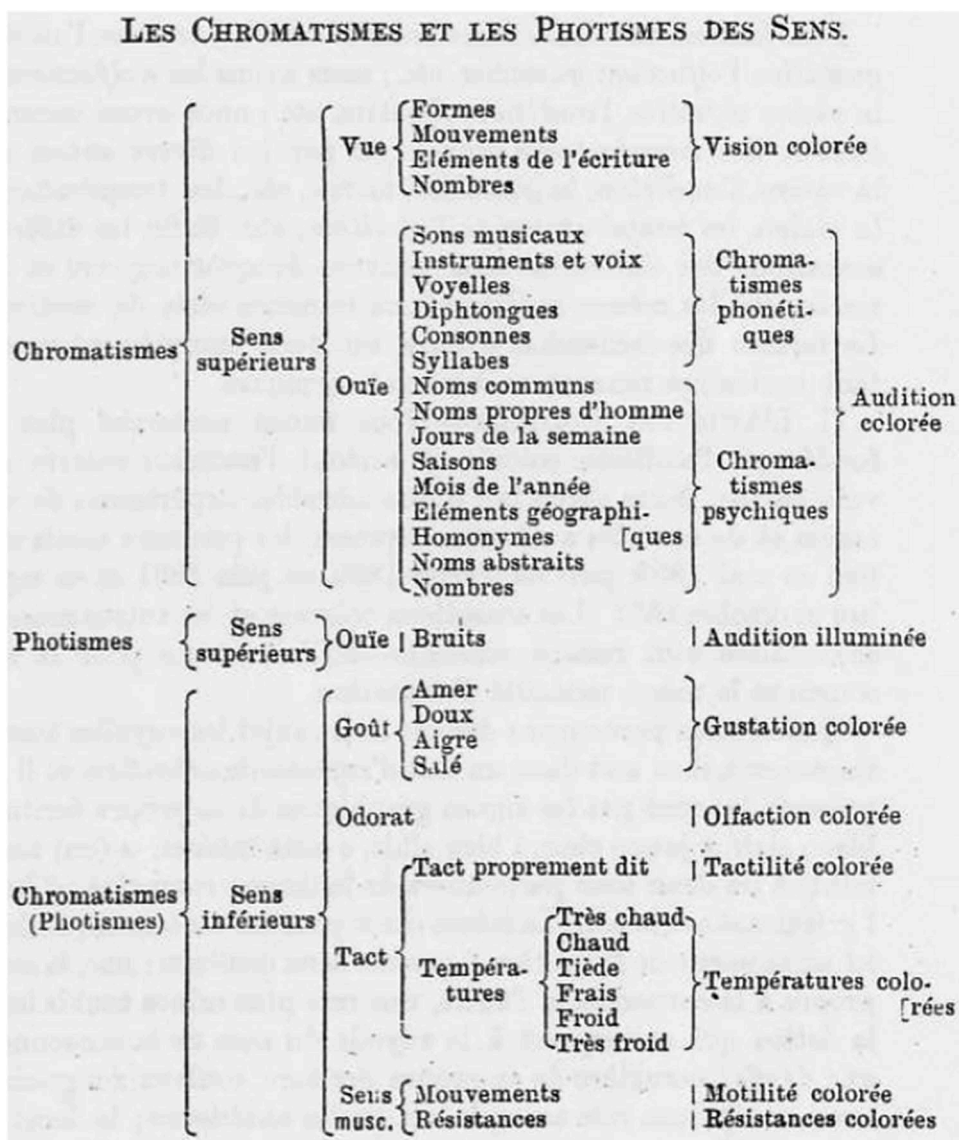


Figure 3. The colorings and the photisms of the senses. (source: Gruber 1892, 11; 1892, ed. 1893a, 2; 1892, ed. 1893b, 394)

In any case, it is an evidence of diseased and debilitated brain-activity, if consciousness relinquishes the advantages of the differentiated perceptions of phenomena, and carelessly confounds the reports conveyed by the particular senses. It is a retrogression to the very beginning of organic development. It is a descent from the height of human perfection to the low level of the mollusc. To raise the combination, transposition and confusion of the perceptions of sound and sight to the rank of a principle of art, to see futurity in this principle, is to designate as progress the return from the consciousness of man to that of the oyster. (Nordau 1892, 254–55; cited from the English translation, Nordau 1898, 142)

His monograph was translated into Russian (1892, transl. 1894), English (1892, transl. 1898), and Spanish (1892, transl. 1902). It was controversially discussed but helped synesthesia to become widespread. Likewise, in 1893 Benjamin F. Underwood wrote:

According to the doctrine of evolution all the other senses have come slowly into existence as so many modifications of feeling. Indeed, hearing and sight, as well as taste, are modes of feeling. Differentiation of feeling has, in the evolutionary processes, corresponded with the differentiation of physical structure. In the lowest form of life there are no developed and defined parts like the organs of hearing, sight, smell, and none such as in the higher animals make possible variety and sensitiveness through touch alone. (Underwood 1893, 330)

In summary, there appear to be two opposing views on the wider value of synesthesia and synesthesia research. One attempted to link it to cognitive ability, as exemplified by Galton and generally accepted by other researchers who tended to be personally acquainted with synesthetes. And a second view came from those who sought to link synesthesia to mental illness and, from an evolutionary perspective, to lower animals. Happily, the latter view appeared to be the less dominant one. Certainly, prominent people of their time were unafraid to speak of their own synesthesia (or that of their family), including, for example, David Starr Jordan (1851–1931), the first president of Stanford University (Jordan 1891).

The most extensive treatment of synesthesia in the nineteenth century: Flournoy 1893

The most extensive treatment of synesthesia in the nineteenth century came in the form of a monograph published under the title *Des Phénomènes de Synopsie* (Synopsis Phenomena), written in 1893 by Théodore Flournoy (1854–1920). Flournoy was a professor of psychology at the University of Geneva, where he had established the psychology department (Nicolas and Charvillat 1998). Flournoy's treatment of synesthesia was impressively extensive and covered a number of aspects highly recognizable to modern neuroscientists and psychologists. Flournoy's preface explained that he drew from two sources: first, from observations he had collected over the previous decade from within his circle of friends and, second, from an investigation conducted during the previous year by his cousin, medical student Edouard Claparède (1873–1940). Claparède later became a famous psychologist, also publishing a detailed study about his brother-in-law (Claparède 1923, 33–35).

According to Flournoy, Claparède was a multiple synesthete who had amassed a large amount of data on the subject via his own research, but he had left this to Flournoy to interpret and present. In doing so, Flournoy's approach was to perform "a comparison of a large number of responses ... [to] allow a kind of early orientation or general overview, which might then serve as a guiding path for later, more detailed examinations of people possessing these phenomena" (1893, 3). A total of 2500 questionnaires were sent out (Flournoy 1892a, 1892b), and 694 people answered, of whom 370 were considered synesthetes (or 14.8% of the original sample; one of these happened to be the Swiss linguist Ferdinand de Saussure [1857–1913], from whose answers ["eminent linguist Mr. X"] Flournoy quoted long passages; Flournoy 1893, 50–52; cf. Joseph 2012, 392–97, 707–08.) Within this group, 190 (51.4%) were female and 180 (48.6%) were male. This is

a ratio of 1.1:1 and is again close to contemporary studies (such as 1.3:1 in Simner and Carmichael 2015), unlike those from the twentieth century, as discussed above.

At the start of his book, Flournoy laid out his ideas on terminology and classification, both within and across different variants of what we now recognize as synesthesia. He also gave their respective prevalences. Flournoy was keen to unite a number of phenomena, and he defined his object of study as, “representations in the visual domain that are triggered by some type of sensation or idea that (on the surface at least) appears to fall outside the ordinary laws of perception and association” (1893, 5). The examples he then gave were people experiencing red when hearing the sound of A (grapheme-color synesthesia), or imagining a number at a particular point on a curve (sequence-space synesthesia), or conceiving of February under a triangle (undetermined by today’s standards), or Monday as a man dressed in blue (sequence-personality synesthesia). Flournoy’s concern with classification and nomenclature leads him to the use the term *synopsia* because he saw limitations with previous terminology. The term *audition colorée* was problematic for him, as it was too narrow for his wish to include variants triggered by vision, and variants whose concurrents were not color. He considered using the term *visual* (and by extension, *auditory*, *olfactory*, etc.) *synesthesia*, and also the term *synkinesia* (original: *syncinesies*) to denote variants involving movement. Although strongly praising the term *synesthesia*, Flournoy ultimately (and perhaps unexpectedly) settled on the term *synopsia* (original: *synopsie*), but he allowed himself to also use the terms *audition colorée* and *synesthesia* as short cuts, and often seemingly interchangeably with *synopsia*.

In many ways, Flournoy’s book is remarkable in its modernity, and he often expressed ideas that contemporary science was to “rediscover” a century later. For example, Flournoy proposed the term *inducer* to designate the trigger for synesthetic experiences, a term coincidentally chosen again by Grossenbacher and Lovelace (2001) at the start of the twenty-first century. The latter also proposed *concurrent* for the trigger stimulus and synesthetic experience, respectively; Flournoy proposed *inducer* and *induced*.

Flournoy divided *synopsia* into four main types: colored alphabets, colors from non-alphabetic stimuli, diagrams (or what we might now call sequence-space synesthesia), and personifications (see Plassart and White 2017, with a complete English translation of Flournoy’s *Des Personnifications*, 1893, 219–27). Importantly, however, and unlike Galton, Flournoy explicitly linked these phenomena under one banner—as different expressions of the same phenomenon, termed *synopsia*.

Flournoy also anticipated other areas of keen contemporary interest—for example, when he categorized concurrents according to their intensity and spatial location. Here, Flournoy distinguished between concurrents that were perceived externally in a similar way as veridical perceptions (e.g., colors projected into space) and those experienced only internally, and this distinction was later to become known as projector and associator synesthesia, respectively (Dixon, Smilek, and Merikel 2004).

Moreover, Flournoy took a particularly fine-grained approach in further dividing this aspect into four (rather than two) categories, an approach that was later mirrored by Ward and colleagues (2007). These four categories formed something of a continuum, from colors that are percept-like and externally projected to colors that are simply understood and not even mentally imaged (cf. also Rothen et al. 2013). Flournoy’s example for this latter is the case of synesthetes who might have a yellow letter I, which “makes them think of yellow,

gives them the idea of it: but far from seeing a yellow surface [projected] in front of them, they don't even have an interior view of it; and are reduced to simply the abstract notion of this color" (Flournoy 1893, 10). Flournoy designated these *thought concurrents*, and Ward and colleagues (2007) later describe such synesthetes as *know-associators*.

Other observations by Flournoy now supported by contemporary research were that synesthesia starts in early childhood (Simner et al. 2009) and fades out across the adult lifespan (Meier, Rothen, and Walter 2014; Simner, Ipser, Smees, and Alvarez 2017).

Flournoy's monograph was reviewed at least eight times in four countries, making it the most widely reviewed monograph on synesthesia of the nineteenth century. The eminent American psychologist Howard C. Warren noted a positive change in the rating of the phenomenon:

Until quite recently synesthesia was regarded by psychologists generally as a purely artificial and fanciful association, or at least a sign of degeneracy; it has lately received considerable attention, however, and the weight of evidence goes to show that it is both natural and normal—it may even be said, a phenomenon of common occurrence. (Warren 1896, 689)

Even the famous American psychologist William James, who had attended the Paris conference in 1889 (and perhaps had visited the symposium on synesthesia), was full of praise:

It [Flournoy's monograph] will fill the reader with a wondering sense of the complication of our mental workshop, and, by increasing his insight into the extraordinary diversities of inner scenery, so to speak, by which different men's minds are characterized, it will tone down his hopes, if he ever had any, of a general union of all intelligences on a purely logical and articulable basis. (James 1894, 92)

Another American review was written by Mary Whiton Calkins (1893b), a student of William James. She conducted her own research on synesthesia, and her main legacy to the history of synesthesia was to advocate the adoption of that term. At this point in history, we can say that the consensus view was that different forms of synesthesia should be grouped together and united by a single word, despite being heterogenous in kind.

The surveys of Mary Whiton Calkins (1892–1896) and her adoption of the term 'synesthesia'

Mary Whiton Calkins (see Figure 4) distinguished herself academically with a number of important historical firsts: She was the first woman to be offered a Ph.D. from Harvard (an honor she declined, as it came from the associated women's college, Radcliffe, rather than from Harvard itself), and the first woman to become president of the American Psychological Association (in 1905) and the American Philosophical Association (in 1918). She began her studies in psychology in 1890 under the tutelage of William James, among others, while also teaching psychology at Wellesley College (a prestigious girls' school near Boston). Her thesis, "An Experimental Research on the Association of Ideas" was defended in 1895. It was during this formative period that Calkins published several papers and reviews on synesthesia. She also invented the method of paired-associate learning in memory research and, notably, used number-color associations as the memoranda.

In her 1893 and 1895 papers, Calkins documented and tabulated many details about synesthesia, including prevalence estimates; whether colors are triggered by hearing or sight; where number forms bend; whether it is vowels or consonants that are colored, and



Figure 4. Calkins is the only woman among this group of famous American psychologists, most of whom also published on synesthesia. Photo taken at Cambridge, Mass., December 29, 1919. From left to right, added are the publications on synesthesia:

Howard C. Warren (1867–1934): Warren [1896](#)

Raymond Dodge (1871–1942): no publications on synesthesia

Robert S. Woodworth (1869–1962): Woodworth [1906](#), [1908](#)

Mary Whiton Calkins (1863–1930): Calkins [1892](#), [1893a](#), [1893b](#), [1895](#), [1896](#)

Carl E. Seashore (1866–1949): Seashore [1938](#)

Robert Morris Ogden (1877–1959): no publications on synesthesia

Walter Dill Scott (1869–1955): no publications on synesthesia

Harry L. Hollingworth (1880–1956): Hollingworth and Weischer [1939](#)

Herbert S. Langfeld (1879–1958): Langfeld [1915](#), [1919](#), [1926](#), [1929](#)

James M. Baldwin (1861–1934): Titchener, Jastrow, and Baldwin [1902](#)

(Photo: Archives of the History of American Psychology, The Drs. Nicholas and Dorothy Cummings Center for the History of Psychology, The University of Akron.)

how this determines word color; and so on. With regard to prevalence, there was clearly something unusual happening in Calkins's methodology, as her three surveys show increases from 15.6% to 33.2% to 60.4% (Calkins [1895](#)). Calkins herself considered the latter figure to be more accurate, as it was based on more precise questioning. However, her earlier estimates (Calkins [1892](#)), which were supplemented by an important stage of verification (i.e., a two-month test–retest of consistency), more closely resemble contemporary ones. It is to be noted that her definition of synesthesia was quite broad, including what she termed “dramatizations” (Calkins [1892](#)) and later “personifications” (Calkins [1895](#)), what we now call sequence-personality synesthesia (i.e., the attribution of genders, personalities, and social relationships for letters and other symbols). In terms of an explanation, Calkins did not dismiss outright biological influences but argued that, on balance, environmental influences (or “psychical” factors, to use her term) were of the greatest importance. For instance, she offered the following account:

[Forms] may be plausibly explained by the hypothesis of forgotten childhood-associations; and this probability is increased by the fact that such associations would be useful in learning

the number series and in remembering dates. ... Musical color-hearing and some name-associations are explained in the same way. Color with the letters may also be accounted for by arbitrary and forgotten childhood-associations; but it is possible that the explanation in this case is primarily a cerebral one. In general, however, such color-associations are either useful or pleasant, so that even if their occasion be cerebral, their continuance, both in the individual and in the family, is largely due to attention and cultivation. (Calkins 1893a, 455)

Perhaps Calkins's most significant legacy is her advocacy of the term synesthesia to describe this particular set of phenomena. The first terms for synesthesia derived from the word color, because all known synesthetes had a stimulus-to-color-synesthesia. For Charles-Auguste-Édouard Cornaz, in his medical dissertation, synesthesia was the opposite of color-blindness; therefore, he named it “hyperchromatopsia (perception of too many colors)” (Cornaz 1848, 150; cf. Jewanski et al. 2012). Chabaliere regarded it not as the perception of too many colors but of false colors, and he named it “pseudochromesthésie” (Chabaliere 1864). Bleuler and Lehmann (1881) named it “secondary sensations or secondary imaginations,” to account for its wide-ranging manifestations, only for one of the reviewers of their work to propose the narrower “colored hearing” (*Farbenhören* and *audition colorée*) (see Das Farbenhören 1881). It was Jules Millet who, in his medical dissertation (1892), had first differentiated between synesthésie for all kinds of combined senses (while *audition colorée* should be limited to those color combinations), but Calkins reinforced the term synesthesia in the general sense, as we know it today. A discussion of the evolution of synesthesia's name was given by Jewanski and colleagues (2018).

Summary and conclusion

During the two decades discussed in this article, the concept of synesthesia became the focus of intense study. Its conception was broadened away from purely color-based experiences to include a wide diversity of diverse phenomena—as we would now recognize synesthesia today. Although there was a general agreement that these phenomena did relate to each other, there was less agreement as to *how* they related, and about their roots in the mind and brain. Were they a variety of mental imagery, or a memory association, or a continuum of cross-modal correspondences, or even a warning sign for pathology? Although the pathological view was largely discounted, there was little clear consensus on other matters.

Given the hiatus in interest for synesthesia during the mid-twentieth century, many of these earlier debates were entirely lost to contemporary researchers. However, the “lessons from history” they provide are highly relevant to current debates—not only for synesthesia but also for our wider understanding of atypical experiences and the broad capacities of the human mind.

Acknowledgments

We want to thank Michael Haverkamp (Cologne, Germany) for providing us with copies of Flournoy 1892b; Gruber 1893a and 1893b.

Funding

The research leading to these results received funding for the first author (JJ) from the *Fonds zur Förderung der wissenschaftlichen Forschung* of Austria (FWF), *Lise Meitner Programme* (M 2440-

G28). This research also received funding for the second author (JS) from the *European Research Council* under the *European Union's Seventh Framework Programme* (FP/2007-2013)/ERC Grant Agreement no. 617678, and for the fourth author (NR) from the *Swiss National Science Foundation* (Grant number: PZ00P1_154954).

References

- Akademisch-Philosophischer Verein Leipzig. 1880. Professor Fechner's Associationsstatistik [Professor Fechner's statistics of associations]. *Leipziger Zeitung* (4), January 11: Wissenschaftliche Beilage, 24 only.
- Banerji, M. N. 1930. Synaesthesia (Sensation and image). *Indian Journal of Psychology* 5: 147–59.
- Baron-Cohen, S., J. Harrison, L. H. Goldstein, and M. Wyke. 1993. Coloured speech perception: Is synaesthesia what happens when modularity breaks down? *Perception* 22(4): 419–26. doi: 10.1068/p220419.
- Barth, A. 1894a. [Review on Gruber 1892, ed. 1893a/b]. *Zeitschrift für Ohrenheilkunde* 25: 342–43.
- Barth, A. 1894b. [Review on Gruber 1892, ed. 1893a/b]. *Archives of Otolaryngology* 23: 331 only.
- Binet, A. 1892a. Le problème de l'audition colorée [The problem of colored hearing]. *La Revue des deux mondes* 113: 586–614.
- Binet, A. 1892b. Colored hearing [English translation of Binet 1892a]. *The Cincinnati Lancet-Clinic* 68(Dec. 3): 766–70, (Dec. 10): 798–804, (Dec. 24): 864–68.
- Binet, A. 1893a. The problem of colored hearing [Shortened English translation of Binet 1892a]. *The Popular Science Monthly* 43: 812–23.
- Binet, A. 1893b. Das Problem des Farbengehörs [German translation of Binet 1892a]. *Medizinisch-pädagogische Monatsschrift für die gesamte Sprachheilkunde* 3: 5–15, 51–54, 353–67.
- Binet, A. [Бине А.] (1894). Вопрос о цветном слухе, пер. с франц. [Russian translation of Binet 1892a]. Moscow [Cited after Б. М. Галеев (Galeev B. M.) (2006). Светомузыка, синестезия, «цветной слух». Аннотированный библиографический указатель. (Россия, 1742–2002) (Light music, synesthesia, 'color hearing'. Annotated bibliography (Russia, 1742–2002)), 2nd enlarged ed., 14 only. Kazan': Fën.]
- Bleuler, E., and K. Lehmann. 1881. Zwangsmässige Lichtempfindungen durch Schall und verwandte Erscheinungen auf dem Gebiete der andern Sinnesempfindungen [Compulsory light sensations through sound and related phenomena in the domain of other sensations]. Leipzig: Fues.
- Burbridge, D. 1994. Galton's 100: An exploration of Francis Galton's imagery studies. *The British Journal for the History of Science* 27(4): 443–63. www.jstor.org/stable/4027625.
- Calkins, M. W. 1892. Experimental psychology at Wellesley College. *The American Journal of Psychology* 5(2): 264–71 [wrong pagination: 464–271]. www.jstor.org/stable/1410869.
- Calkins, M. W. 1893a. A statistical study of pseudo-chromesthesia and of mental-forms. *The American Journal of Psychology* 5(4): 439–64. www.jstor.org/stable/1411912.
- Calkins, M. W. 1893b. [Review on Flournoy 1893]. *The American Journal of Psychology* 5(4): 550–51. www.jstor.org/stable/1411924.
- Calkins, M. W. 1895. Synaesthesia. *The American Journal of Psychology* 7(1): 90–107. www.jstor.org/stable/1412040.
- Calkins, M. W. 1896. [Review on an article by Henning 1896]. *Psychological Review* 3(5): 581–82. doi: 10.1037/h0068047.
- Chabalière. 1864. De la pseudochromesthésie [About pseudochromesthesia]. *Journal de médecine de Lyon* 1(2): 92–102.
- Chun, Ch.A. and J.-M. Hupé. 2013. Mirror-touch and ticker tape experiences in synesthesia. *Frontiers in Psychology* 4, article 776: 13 pp. doi: 10.3389/fpsyg.2013.00776.
- Claparède, E. 1923. Théodore Flournoy. Sa vie et son œuvre. 1854–1920. *Archives de Psychologie* 18: 1–124.
- Colour-Hearing. 1882. *The Times* (London), January 12: 5 only.
- Cornaz, C.-A.-É. 1848. Des abnormité congéniales des yeux et de leurs annexes [Congenital abnormalities of the eyes and their appendices]. Lausanne: Bridel.

- Das Farbenhören [Colored hearing]. [Review on Bleuler and Lehmann 1881]. *Neue Freie Presse*, (6076), July 28: Abendblatt, 4 only.
- Deroy, O., and C. Spence. 2013. Why we are not all synesthetes (not even weakly so). *Psychonomic Bulletin & Review* 20(4): 643–64. doi: [10.3758/s13423-013-0387-2](https://doi.org/10.3758/s13423-013-0387-2).
- Dixon, M. J., D. Smilek, and P. M. Merikle. 2004. Not all synaesthetes are created equal: Projector vs. associator synaesthetes. *Cognitive, Affective and Behavioral Neuroscience* 4(3): 335–43. doi: [10.3758/CABN.4.3.335](https://doi.org/10.3758/CABN.4.3.335).
- [F. B. D.] 1894. [Review on Gruber 1892, ed. 1893a/b]. *The American Journal of Psychology* 6(2): 305 only. www.jstor.org/stable/1410986.
- Fechner, G. T. 1860. [transl. 1966] *Elements of psychophysics*. New York: Holt, Rinehart and Winston.
- Fechner, G. T. 1860. *Elemente der Psychophysik* [Elements of psychophysics]. 2 Vol. Leipzig: Breitkopf & Härtel.
- Fechner, G. T. 1876. *Vorschule der Aesthetik* [Preschool of aesthetics]. 2 Vol. Leipzig: Breitkopf and Härtel.
- Flournoy, T. 1892a. [Enquête sur l'audition colorée] [Questionnaire on colored hearing]. *Archives des Sciences Physiques et Naturelles* 3/28(11): 505–08.
- Flournoy, T. 1892b. [Flournoy 1892a]. Offprint, 4 pp. [Archive Michael Haverkamp, Cologne, Germany].
- Flournoy, T. 1893. *Des phénomènes de synopsie (audition colorée)* [Of synoptic phenomena (colored hearing)]. Paris: Alcan.
- Galton, F. 1880a. Visualised numerals. *Nature* 21(533 = January 15): 252–56. doi: [10.1038/021252a0](https://doi.org/10.1038/021252a0).
- Galton, F. 1880b. Visualised numerals. Letter to the editor. *Nature* 21(536 = February 5): 323 only. doi: [10.1038/021323a0](https://doi.org/10.1038/021323a0).
- Galton, F. 1880c. Visualised numerals. *Nature* 21(543 = March 25): 494–95. doi: [10.1038/021494e0](https://doi.org/10.1038/021494e0).
- Galton, F. 1880d. Statistics of mental imagery. *Mind: A Quarterly Review of Psychology and Philosophy* 5(19): 301–18. www.jstor.org/stable/2246391.
- Galton, F. 1880e. Mental imagery. *The Fortnightly Review* 28(165): 312–24. Reprint 1880: *The Popular Science Monthly* 18(Nov.): 64–76.
- Galton, F. 1880f. *Visualised numerals: A memoir read before the Anthropological Institute on March 9, 1880, with the remarks of various speakers thereon*. London: Harrison and Sons. Reprint 1880: *Journal of the Anthropological Institute of Great Britain and Ireland* 10: 85–102.
- Galton, F. 1881. The visions of sane persons. *The Fortnightly Review* 29(174): 729–40. Reprint with slight revisions 1881: *Proceedings of the Royal Institution of Great Britain* 9: 644–55. Reprint 1881: *The Popular Science Monthly* 19: 519–31.
- Galton, F. 1883. *Inquiries into human faculty and its development*. London: Macmillan and Co.
- Galton, F. 1892. [Remarks to an article by Gruber]. In Gruber 1892, 20 only.
- Grossenbacher, P. G., and C. T. Lovelace. 2001. Mechanisms of synaesthesia: Cognitive and physiological constraints. *Trends in Cognitive Sciences* 5(1): 36–41. doi: [10.1016/S1364-6613\(00\)01571-0](https://doi.org/10.1016/S1364-6613(00)01571-0).
- Gruber, E. 1892. L'audition colorée et les phénomènes similaires [Colored hearing and similar phenomena]. In *International Congress of Experimental Psychology, Second Session, London, 1892*, 10–20. London: Williams & Norgate [with remarks by Francis Galton, 20 only].
- Gruber, E. 1893a. [Gruber 1892]. Offprint London: Eberhard & Jacot, 11 pp. [with Francis Galton as coauthor in the first place; Archive Michael Haverkamp, Cologne, Germany].
- Gruber, E. 1893b. [Gruber 1892]. *Revue scientifique* 51(13): 394–98 [without remarks by Galton].
- Gruber, E. 1893c. Questionnaire psychologique sur l'audition colorée, figurée et illuminée [Psychological questionnaire on colored hearing, figured hearing and illuminated hearing]. *Revue philosophique* 35: 499–502.
- Gruber, E. 1893d. *Psychologischer Fragebogen über Gehörfarben, Gehörfiguren und Gehörehelligkeiten* [Psychological questionnaire on colored hearing, figured hearing and illuminated hearing]. Flyer [Archive Michael Haverkamp, Cologne, Germany].
- Hey, R. 1930. Francis Galton's Untersuchungen über das bildhafte Vorstellen [Francis Galton's Investigations on Mental Imagery]. *Archiv für die gesamte Psychologie* 76: 353–86.

- Hollingworth, H. L., and V. Weischer. 1939. Persistent alphabetical synesthesia. *The American Journal of Psychology* 52(3): 361–66. www.jstor.org/stable/1416743.
- James, W. 1889. The congress of physiological psychology at Paris. *Mind. A Quarterly Review of Philosophy* 14(56): 614–15. www.jstor.org/stable/2247135.
- James, W. 1894. [Review of Flournoy 1893]. *The Philosophical Review* 3(1): 88–92. www.jstor.org/stable/2175462.
- Jastrow, J. 1883. Association of colors with sounds. *The Popular Science Monthly* 23: 848–49 [spelled wrongly as Jostrow].
- Jewanski, J., S. A. Day, and J. Ward. 2009. A colorful albino: The first documented case of synaesthesia, by Georg Tobias Ludwig Sachs in 1812. *Journal of the History of the Neurosciences* 18(3): 293–303. doi: [10.1080/09647040802431946](https://doi.org/10.1080/09647040802431946).
- Jewanski, J., S. A. Day, J. Simner, and J. Ward. 2013. The beginnings of an interdisciplinary study of synaesthesia: Discussions about the Nussbaumer brothers (1873). *Theoria et Historia Scientiarum. An International Journal for Interdisciplinary Studies* 10: 149–76. doi: [10.2478/ths-2013-0008](https://doi.org/10.2478/ths-2013-0008).
- Jewanski, J., J. Simner, S. A. Day, and J. Ward. 2011. The development of a scientific understanding of synesthesia from early case studies (1849–1873). *Journal of the History of the Neurosciences* 20(4): 284–305. doi: [10.1080/0964704X.2010.528240](https://doi.org/10.1080/0964704X.2010.528240).
- Jewanski, J., J. Simner, S. A. Day, and J. Ward. 2012. Édouard Cornaz (1825–1911) and his importance as founder of synaesthesia research. *Musik-, Tanz- & Kunsttherapie* 23(2): 78–86. doi: [10.1026/0933-6885/a000075](https://doi.org/10.1026/0933-6885/a000075).
- Jewanski, J., J. Simner, S. A. Day, N. Rothen, and J. Ward. 2015. The accolade. The first symposium on synaesthesia during an international congress: Paris 1889. In *Actas V Congreso Internacional de Sinestesia: Ciencia y Arte (Alcalá la Real, 2015)*, ed. S. A. Day, M. José De Córdoba, D. Riccò, J. López de la Torre Lucha, J. Jewanski, and P. A. Galera Andreu, 197–211. Jaén: Instituto de Estudios Giennenses.
- Jewanski, J., J. Simner, S. A. Day, N. Rothen, and J. Ward. 2018. From ‘obscure feeling’ to ‘synesthesia.’ The development of the term for the condition, we today name ‘synesthesia.’ In *Actas VI Congreso Internacional de Sinestesia: Ciencia y Arte (Alcalá la Real, May, 18–21, 2018)*, ed. M. José De Córdoba Serrano, J. Lopez de la Torre Lucha, and T. B. Layden, 67–74. Granada: Artecittà (e-Book).
- Johnson, D., C. Allison, and S. Baron-Cohen. 2013. The prevalence of synesthesia. In *The Oxford Handbook of Synesthesia*, ed. J. Simner and E. M. Hubbard, 3–22. Oxford, UK: Oxford University Press.
- Jordan, D. S. 1891. The colors of letters. *The Popular Science Monthly* 39: 367–73.
- Joseph, J. E. 2012. *Saussure*. Oxford, UK: Oxford University Press.
- Kaiser, H. 1872. *Compendium der physiologischen Optik* [Compendium of the physiological optics]. Wiesbaden: C. W. Kreidel’s Verlag.
- Kaiser, H. 1882. Association der Worte mit Farben [Association of words with colors]. *Archiv für Augenheilkunde* 11: 96 only.
- Langfeld, H. S. 1915. Synaesthesia [review on new publications]. *Psychological Bulletin* 12(3): 121–22. doi: [10.1037/h0074351](https://doi.org/10.1037/h0074351).
- Langfeld, H. S. 1919. Synesthesia [review on new publications]. *Psychological Bulletin* 16(4): 148–50. doi: [10.1037/h0069907](https://doi.org/10.1037/h0069907).
- Langfeld, H. S. 1926. Synesthesia [review on new publications]. *Psychological Bulletin* 23(10): 599–602. doi: [10.1037/h0071551](https://doi.org/10.1037/h0071551).
- Langfeld, H. S. 1929. Synesthesia [review on new publications]. *Psychological Bulletin* 26(9): 582–85. doi: [10.1037/h0073933](https://doi.org/10.1037/h0073933).
- Lewes, G. H. 1879. *Problems of life and mind (third series)*. London: Trubner & Co.
- Lussana, F. 1873. *Fisiologia dei colori* [Physiology of colors]. Padova: F. Sacchetto.
- Maftai, I. 1978. Gruber, Eduard. In *Personalități Ieșene*, Vol. 3, 148–50. Iași, Romania: Comitetul de Cultură și Educație Socialistă al Județului.
- Marks, L. E. 2013. Weak synesthesia in perception and language. In *The Oxford Handbook of Synesthesia*, ed. J. Simner and E. M. Hubbard, 761–89. Oxford, UK: Oxford University Press.

- Martino, G., and L. E. Marks. 2001. Synesthesia: Strong and weak. *Current Directions in Psychological Science* 10(2): 61–65. doi: [10.1111/1467-8721.00116](https://doi.org/10.1111/1467-8721.00116).
- Maurer, D., L. C. Gibson, and F. Spector. 2013. Synesthesia in infants and very young children. In *The Oxford Handbook of Synesthesia*, ed. J. Simner and E. M. Hubbard, 46–63. Oxford, UK: Oxford University Press.
- Meier, B., N. Rothen, and S. Walter. 2014. Developmental aspects of synaesthesia across the adult lifespan. *Frontiers in Human Neuroscience* 8, article 129 (March, 11). doi: [10.3389/fnhum.2014.00129](https://doi.org/10.3389/fnhum.2014.00129).
- Mercante, V. 1908. La audición coloreada en los escolares [Colored hearing in school children]. *El Monitor de la Educación Común* (Buenos Aires) 28/26(427): 418–39.
- Millet, J. 1892. *Audition colorée* [Colored hearing]. Montpellier, France: Hamelin frère.
- Nicolas, S., and A. Charvillat. 1998. Théodore Flournoy (1854–1920) and experimental psychology: Historical note. *The American Journal of Psychology* 111(2): 279–94. www.jstor.org/stable/1423490.
- Nordau, M. 1892. *Entartung* [Degeneration], Vol. 1. Berlin: Duncker.
- Nordau, M. 1894. *Vyrozhenie* [Russian translation of Nordau 1892]. St. Petersburg: F. Pavlenkov.
- Nordau, M. 1898. *Degeneration* [English translation of Nordau 1892]. London: Heinemann.
- Nordau, M. 1902. *Degeneración* [Spanish translation of Nordau 1892]. Madrid: Librería de Fernando Fé.
- Nussbaumer, F. A. 1873a. Ueber subjektive *Farbenempfindungen*, die durch objektive *Gehörempfindungen* erzeugt werden. Eine Mittheilung durch Beobachtungen an sich selbst [About subjective ‘color’ sensations, which are aroused from objective ‘sound’ sensations. A paper based on observations of himself]. *Wiener Medizinische Wochenschrift* (1): 4–7, (2): 28–31, (3): 52–54.
- Nussbaumer, F. A. 1873b. Ueber subjective *Farben-Empfindungen*, welche durch objective *Gehör-Empfindungen* erzeugt werden [About subjective color sensations, which are aroused from objective sound sensations]. *Mittheilungen des Aerztlichen Vereines in Wien* 2(5): 49–63.
- Patrick, G. T. W. 1893. Number forms. *The Popular Science Monthly* 42: 504–14.
- Pearson, K. 1924. *The life, letters and labours of Francis Galton, Vol. II: Researches of middle life*. Cambridge, UK: Cambridge University Press.
- Pédrono, L.-M.-A. 1882a. De l’audition colorée [On Colored Hearing]. *Journal de médecine de l’ouest* 2/6/16: 294–311.
- Pédrono, L.-M.-A. 1882b. De l’audition colorée [On Colored Hearing]. *Annales d’oculistique* 88: 224–37.
- Plassart, A., and R. C. White. 2017. Théodore Flournoy on synesthetic personification. *Journal of the History of the Neurosciences* 26(1): 1–14. doi: [10.1080/0964704X.2015.1077542](https://doi.org/10.1080/0964704X.2015.1077542).
- Pouchet, G., and F. Tourneux. 1878. *D’histologie humaine et d’histogenie* [Human histology and histogenesis]. Paris: G. Masson.
- Root, N. B., M. Asano, K. Chai-Youn, H. Melero, K. Yokosawa, and V. S. Ramachandran. 2018. Why is the synesthete’s “A” red? Using a five-language dataset to disentangle the effects of shape, sound, semantics, and ordinality on inducer–concurrent relationships in grapheme-color synesthesia. *Cortex* 99: 375–89. doi: [10.1016/j.cortex.2017.12.003](https://doi.org/10.1016/j.cortex.2017.12.003).
- Rothen, N., E. Tsakanikos, B. Meier, and J. Ward. 2013. Coloured Letters and Numbers (CLaN): A reliable factor-analysis based synaesthesia questionnaire. *Consciousness and Cognition* 22(3): 1047–60. doi: [10.1016/j.concog.2013.07.005](https://doi.org/10.1016/j.concog.2013.07.005).
- Rouw, R., H. S. Scholte, and O. Colizoli. 2011. Brain areas involved in synaesthesia: A review. *Journal of Neuropsychology* 5: 214–42. doi: [10.1111/j.1748-6653.2011.02006.x](https://doi.org/10.1111/j.1748-6653.2011.02006.x).
- Sagiv, N., J. Simner, J. Collins, B. Butterworth, and J. Ward. 2006. What is the relationship between synaesthesia and visuo-spatial number forms? *Cognition* 101: 114–28. doi: [10.1016/j.cognition.2005.09.004](https://doi.org/10.1016/j.cognition.2005.09.004).
- Seashore, C. E. 1938. Color music. *Music Educators Journal* 25(2): 26 only. www.jstor.org/stable/3385337.
- Sidoroff-Dorso, A. 2012. La investigación de la sinestesia en Rusia: Arte y ciencia [Synaesthesia research in Russia: Arts and science]. In *Sinestesia: Los fundamentos teóricos, artísticos y científicos*, ed. M. José De Córdoba, and D. Riccò, 231–73. Granada: Artecittà.

- Sidoroff-Dorso, A. 2014. Synaesthesia research in Russia: Arts and science [English translation of Sidoroff-Dorso 2012]. In *Synaesthesia: Theoretical, Artistic and Scientific Foundations*, ed. M. José De Córdoba, D. Riccò, and S. A. Day, 286–330. Granada: Artecittà.
- Simner, J., and D. A. Carmichael. 2015. Is synaesthesia a dominantly female trait? *Cognitive Neuroscience* 6(2–3): 68–76. doi: [10.1080/17588928.2015.1019441](https://doi.org/10.1080/17588928.2015.1019441).
- Simner, J., J. Harrold, H. Creed, L. Monro, and L. Foulkes. 2009. Early detection of markers for synaesthesia in childhood populations. *Brain* 132(1): 57–64. doi: [10.1093/brain/awn292](https://doi.org/10.1093/brain/awn292).
- Simner, J., and E. M. Hubbard, eds. 2013. *The Oxford Handbook of Synesthesia*. Oxford, UK: Oxford University Press.
- Simner J., A. Ipser, R. Smees, and J. Alvarez. 2017. Does synaesthesia age? Changes in the quality and consistency of synaesthetic associations. *Neuropsychologia* 106: 407–16. doi: [10.1016/j.neuropsychologia.2017.09.013](https://doi.org/10.1016/j.neuropsychologia.2017.09.013).
- Simner, J., M. Lanz, A. Jansari, K. Noonan, L. Glover, D. A. Oakley, and J. Ward. 2005. Non-random associations of graphemes to colours in synaesthetic and normal populations. *Cognitive Neuropsychology* 22(8): 1069–85. doi: [10.1080/02643290500200122](https://doi.org/10.1080/02643290500200122).
- Simner, J., and V. U. Ludwig. 2011. The color of touch: A case of tactile-visual synaesthesia. *Neurocase* 18(2): 167–80. doi: [10.1080/13554794.2011.568503](https://doi.org/10.1080/13554794.2011.568503).
- Simner, J., C. Mulvenna, N. Sagiv, E. Tsakanikos, S. A. Witherby, C. Fraser, K. Scott, and J. Ward. 2006. Synaesthesia: The prevalence of atypical cross-modal experiences. *Perception* 35: 1024–33. doi: [10.1068/p5469](https://doi.org/10.1068/p5469).
- Société de psychologie physiologique (ed.) 1890. *Congrès international de psychologie physiologique: Première session—Paris, 1890. Compte rendu* [International Congress on Psychological Physiology. First Session—Paris 1890. Proceedings]. Paris: Bureau des Revues.
- Steinbrügge, H. 1887. *Über secundäre Sinnesempfindungen* [On secondary sensations of the senses]. Wiesbaden: Bergmann.
- Suarez de Mendoza, F. 1890. *L’audition colorée* [Colored hearing]. Paris: Octave Doin.
- Titchener, E. B., J. Jastrow, and J. M. Baldwin. 1902. Synaesthesia. In *Dictionary of Philosophy and Psychology*, ed. J. M. Baldwin, Vol. 2, 654–55. New York: MacMillan.
- Underwood, B. F. 1893, June 16. Association of colors with sounds. *Science* 21(541): 329–30. doi: [10.1126/science.ns-21.541.329](https://doi.org/10.1126/science.ns-21.541.329).
- Urbantschitsch, V. 1883. Ueber den Einfluss von Trigeminus-Reizen auf die Sinnesempfindungen, insbesondere auf den Gesichtssinn [On the influence of trigeminus stimuli on sensory perception, especially on the sense of sight]. (*Pflügers*) *Archiv für die gesamte Physiologie* 30: 129–75.
- Ward, J. 2013. Synesthesia. *Annual Review of Psychology* 64: 49–75. doi: [10.1146/annurev-psych-113011-143840](https://doi.org/10.1146/annurev-psych-113011-143840).
- Ward, J., S. Salih, R. Li, and N. Sagiv. 2007. Varieties of grapheme-colour synaesthesia: A new theory of phenomenological and behavioural differences. *Consciousness and Cognition* 16(4): 913–31. doi: [10.1016/j.concog.2006.09.012](https://doi.org/10.1016/j.concog.2006.09.012).
- Warren, H. C. 1896. [Review on Flournoy 1893]. *The American Naturalist* 30(356): 689–90. www.jstor.org/stable/2453397.
- Woodworth, R. S. 1906. [Review on a lecture by Pierce from 1906]. *The Journal of Philosophy, Psychology and Scientific Methods* 4(3): 77 only. www.jstor.org/stable/2011853.
- Woodworth, R. S. 1908. [Review on a monograph by Sidis from 1908]. *The Journal of Philosophy, Psychology and Scientific Methods* 5(17): 472–74. www.jstor.org/stable/2011675.
- Wundt, W. 1874. *Grundzüge der physiologischen Psychologie* [Fundamentals of physiological psychology]. Leipzig: Engelmann.

Appendix

Bleuler and Lehmann's 10 rules of synesthesia

Bleuler and Lehmann (1881, unpagged, after p. 71) provided their readers ten general rules, based on the interviews with their 76 subjects. These rules are shown below.

- (1) Bright photisms are elicited through high pitched sounds, intense pain, sharply defined tactile sensations, small shapes, and pointy shapes; ark photisms through the opposite.
- (2) High pitched phonisms are elicited through: bright light, sharp definition, small shapes. Low pitched phonisms through the opposite.
- (3) Photisms with sharply defined shapes, small photisms, pointy photisms are elicited through high pitched sound sensations.
- (4) Red, yellow, and brown are frequent photism colors; violet and green are rare; concerning frequency, blue is in the middle.
- (5) Continuous correspondence of particulars from different persons does not occur.
- (6) Unpleasant primary sensations are able to elicit pleasant secondary sensations and vice versa.
- (7) The secondary sensations are not more influenced by psychological processes than the primary sensations; moreover, they are invariable.
- (8) The predisposition to secondary sensations is heritable.
- (9) Traces of secondary sensations are very distributed. We [Bleuler and Lehmann] were able to find more developed secondary sensations for 1/8 of all interrogated persons.
- (10) With psychopathic burdened persons, secondary sensations are not more common than with normal [persons].

Gruber's Synesthesia Questionnaire of 1893

The following questionnaire was published by Gruber in French (1893a) and also in German (1893b).

Psychological Questionnaire on Colored Hearing, Figured Hearing and Illuminated Hearing

Colored Hearing

- (1) What color do you think of, what color sensation do you feel, what color do you see, when you hear the different notes on the scale (do, re, mi, fa, sol, la, ti, do), the vowels (a, e, i, o, u, ä, ö, ü), the consonants, syllables and the diphthongs? Do you link colors equally across different keys?
- (2) Do you have ideas of different colors when hearing different pieces of music by the same composer or different composers?
- (3) Do you experience any differences in a single color or even different colors when listening from *do* to *sol* etc., performed by different instruments: piano, violin, flute, cello, trumpet, clarinet, oboe, hunting horn, bassoon?
- (4) Do you experience identical phenomena when hearing different kind of words, nouns (concrete, abstract), adjectives, verbs etc.

- (5) Do particular homonyms trigger different colors (*acquit/acquis, air/aire/ère, alène/haleine*). If you experience any other similar type of phenomenon, please note this here.
- (6) When you think about objects that already have their own color, have you ever by chance had a novel color sensation? In pronouncing the word 'blood', have you ever, for example, had the sensation of blue, or yellow etc.?
- (7) Do the different languages German, French, English, Italian etc. provoke colored sensations?
- (8) What subjective sensations (colors, arrays, diagrams) do you experience when you hear the days of the week, months and seasons? Do you experience any analogue for hours, ages, centuries, historical periods?
- (9) Do you have colored sensations and arrays or only one of them, or even other types, when you hear the names of towns, countries, mountains, rivers and seas etc.?
- (10) Do you have specific colored sensations and arrays when you hear the names of people you know (relatives, friends) or people you don't know?
- (11) What colored sensations of arrays do you experience when you hear either the names of nice people, or unpleasant people? Does it ever happen, by chance, that the name of the person seems nice to you but the person himself unpleasant, and vice versa? Is it possible for you to specify precisely to what degree this is pleasant or unpleasant? Is your liking or disliking of this person ever prompted by the color or array itself?
- (12) When hearing numbers, have you noticed colors or arrays? How do simple digits 0 to 9 seem to you? What about the order of those following; for example, 10, 167, 1892 etc.? Can you see a rule to this by any chance?

Figured Hearing

- (13) What lines, shapes or volumes do you think of—either as a sensation or as something you see—when you hear the different notes of the musical scales (do, re, mi, fa, sol, la, ti, do) vowels (a, e, i, o, u, ä, ö, ü), consonants, syllables or diphthongs?
- (14) Do you also link certain shapes to words: nouns (concrete or abstract), adjectives, verbs etc.? Is there a difference between certain types of words within the same class?
- (15) Do you have the sensation of a shape/figure when thinking about different styles of architecture, different schools of painting or music, or about the different masters of these arts?
- (16) Do analogical phenomena show themselves to you when listening to numbers? How do simple units from 0–9 manifest to you, and those of the orders that following; for example, 10, 167, 1892 etc.? Do you have the sensation of a particular shape or special schema when you think about a series of numbers? Can you infer a law from this?

Illuminated Hearing

- (17) There are certain people who experience brightnesses when hearing sounds. I ask that they allow me to partake in these sensations that are provoked in them by

several of the sounds expressed by the following words: roar, rustling, thunder, whispering, grinding, murmuring, rattle, rattle (i.e., another word for rattle), roar (i.e., another word for roar), rustling (i.e., another word for rustling), buzz, sizzling, etc. Do you hear colored sensations at the same time?

- (18) Do you have light or color sensations, when hearing sudden noises such as those expressed by the verbs hit, break, detonate, slam, shoot (a firearm) etc.?
- (19) Has it ever happened that, when listening to music (particularly an orchestra), you've had only a sensation of light as opposed to color?

Generalities

- (20) When did you notice these facts in yourself for the very first time? And how do you explain the appearance of these things? Have you noticed these phenomena varying in their intensity, being stronger or weaker?
- (21) Among your close family (father, mother, brothers, sisters, children), does there exist anyone capable of double-sensations? Do you know anybody (who has become) blind or deaf, who is capable of these things?
- (22) Do you know of any texts that have treated this subject (particularly, those from novels, artists' biographies, works on theoretical music etc.)?
- (23) Do you attach to it a good feeling, bad feeling or indifferent feeling?
- (24) Do you attach vowels, musical notes of a scale, keys or other sense perceptions to different temperaments or to different sentiments?
- (25) What service do double-sensations provide for you?
 - a. Do you use them as a mnemonic strategy?
 - b. Do you use them as an artist to find and retain small nuances in color?
 - c. Do you use them as a singer, or if you're not a musician, to distinguish tones?
 - d. Do they help you to write correctly in a foreign language?
- (26) Apart from the above-mentioned phenomena, do you notice any similar examples in yourself? For example, when you see colors or think about them, do you have auditory experiences? Do you attach other sensations of color, sound, touch to taste sensations, smells, sensations of temperature etc., and vice versa? We would be happy to have your opinion on colored smell and taste.

Observations

- (27) Where responses are in the affirmative, please do state your preference for the expressions 'I think,' 'I have the sensation,' 'I see,' to characterize the degree of intensities of these subjective phenomena.
- (28) To express the quality of the phenomena, one will need to use the words 'definitely definable,' 'not definitely definable.'
- (29) Those people capable of Hearing in Arrays are kindly requested to give a representative image in addition to their description.

References

- Bleuler, E., and K. Lehmann. 1881. *Zwangsmässige Lichtempfindungen durch Schall und verwandte Erscheinungen auf dem Gebiete der andern Sinnesempfindungen* [Compulsory light sensations through sound and related phenomena in the domain of other sensations]. Leipzig: Fues.
- Gruber, E. 1893a. Questionnaire psychologique sur l'audition colorée, figurée et illuminée [Psychological questionnaire on colored hearing, figured hearing and illuminated hearing]. *Revue Philosophique* 35: 499–502.
- Gruber, E. 1893b. *Psychologischer Fragebogen über Gehörfarben, Gehörfiguren und Gehörhelligkeiten* [Psychological questionnaire on colored hearing, figured hearing and illuminated hearing]. Flyer [Archive Michael Haverkamp, Cologne, Germany].